DOCUMENT RESUME

ED 447 828 IR 057 950

AUTHOR Katsirikou, Anthi; Skiadas, Christos; Apostolou, Apostolos; Rompogiannakis, Giannis

TITLE Virtual Libraries: Interactive Support Software and an Application in Chaotic Models.

PUB DATE 2000-07-00

NOTE 11p.; In: Virtual Libraries: Virtual Communities. Abstracts, Fulltext Documents and PowerPoint Presentations of Papers and Demos Given at the International Association of Technological University Libraries (IATUL) Conference (Brisbane, Queensland, Australia, July 3-7, 2000); see IR 057 942.

AVAILABLE FROM For full text: http://educate.lib.chalmers.se/iatul/proceedcontents/qutpap/katsirik_full.html.

PUB TYPE Reports - Descriptive (141) -- Speeches/Meeting Papers (150)

EDRS PRICE MF01/PC01 Plus Postage.

DESCRIPTORS *Chaos Theory; Computer Software; *Electronic Libraries; Information Technology; Library Collections; Library Services; Models; Organizational Change; Systems Approach

IDENTIFIERS Fractals

ABSTRACT

This paper begins with a discussion of the characteristics and the singularity of chaotic systems, including dynamic systems theory, chaotic orbit, fractals, chaotic attractors, and characteristics of chaotic systems. The second section addresses the digital libraries (DL) concept and the appropriateness of chaotic models, including definition and characteristics of the digital library, collection, material technical organization, users and the circulation of knowledge, and organizational changes. (Contains 12 references.) (MES)

Reproductions supplied by EDRS are the best that can be made from the original document.

PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL HAS BEEN GRANTED BY
N. Fjallbrant
U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)
This document has been reproduced as received from the person or organization originating it.
Minor changes have been made to improve reproduction quality.
Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

IATUL

ED 447 828

VIRTUAL LIBRARIES: INTERACTIVE SUPPORT SOFTWARE AND AN APPLICATION IN CHAOTIC MODELS

Anthi Katsirikou, Christos Skiadas, Apostolos Apostolou, Giannis Rompogiannakis
Technical University of Crete,
Campus, 73100 Chania, Greece
E-mail: anthi@library.tuc.gr

Introduction

We are living in a world that is becoming more and more complex. As individuals and as societies, people are finding it increasingly difficult to cope with a world that daily becomes more complex and uncertain.

Uncertainty is stalking organizations and institutions, and as such libraries too. These bastions of order, regularity, and stability are now under threat. The crises affecting the general level of society also affects institutions. Currents of change are rolling through every domain of society, shaking the stable state. Today there is no established institution in society that perceives itself as adequate to the challenges it faces. There is an evolving shared vision of the new information world. It is a world of ubiquitous, reasonably priced digital information in any and all media, available to everyone from a computer, television, palm, or wrist, as predictable, ordinary and universal as a toaster. Traditional universities are being placed with cyber-universities. If existing universities do not reform quickly, they will decline into irrelevance. They have to work together to create a series of regional and national resources centers to assure that scholarly resources are acquired and preserved (11).

In the digital age, a fundamental question is often overlooked. That question is are libraries being pushed by the past or are they being called by future? (5). The truth is that we cannot forecast with any degree of certainty the mindset of future "information societies (4).

A digital library will provide a range of searching and browsing tools. This seems to be universally accepted, not least because a digital library, unlike a traditional library, will be unusable without a full array of such tools (1).

The characteristics and the singularity of Chaotic Systems

Sir Isaac Newton brought to the world the idea of modeling the motion of physical systems with equations. It was necessary to invent calculus along the way, since fundamental equations of motion involve velocities and accelerations, which are derivatives of position. His greatest single success was his discovery that the motion of the planets and moons of the solar system resulted from a single fundamental source: the gravitational attraction of the bodies. The circular, elliptical, and parabolic orbits of astronomy were no longer fundamental determinants of motion, but were approximations of Laws specified with differential equations. His method is now used in modeling motion and change in all areas of science.

Subsequent generations of scientists extended the method of using differential equations to describe how physical systems evolve. But the method had limitations. Scientists knew of systems, which had more complicated behavior, such as a pot of boiling water, or the molecules of air colliding in a room. However, since these systems were composed of an immense number of interacting particles, the complexity of their motions was not held to be surprising.

Around 1975, after three centuries of study, scientists in large numbers around the world suddenly

IR057950

BEST COPY AVAILABLE

became aware that there is a third kind of motion, that we now call "chaos". The new motion is erratic, but not simply quasi periodic with a large of periods, and not necessarily due to a large number of interacting particles. It is a type of behavior that is possible in very simple systems.

Dynamic Systems Theory
In the present day, scientists realize that chaotic behavior can be observed in experiments and in computer models of behavior from all fields of science. The key requirement is that the system involves a non-linearity. It is now common for experiments whose previous anomalous behavior was attributed to experiment error or noise to be reevaluated for an explanation in these new terms. Taken together, these new terms form a set of unifying principles, often called dynamical systems theory, that cross many disciplinary boundaries. A dynamical system consists of a set of possible states, together with a rule that determines the present state in terms of past states.

The theory of dynamical systems describes phenomena that are common to physical and biological systems throughout science. It has benefited greatly from the collision of ideas from mathematics and these sciences. The goal of scientists and applied mathematicians is to find nature's unifying ideas or laws and to fashion a language to describe these ideas. It is critical to the advancement of science that exacting standards are applied to what is meant by knowledge.

Those standards of mathematicians and scientists are rather different. Mathematicians prove theorems. Scientists look at realistic models. Their approaches are somewhat incompatible. The first papers showing chaotic behavior in computer studies of very simple models were distasteful to both groups. The mathematicians feared that nothing was proved so nothing was learned. Scientists said those models without physical quantities like charge, mass, energy, or acceleration could not be physical studies. But further reflection led to a change in viewpoints.

Finally, laboratory experiments began to be carried out that showed unequivocal evidence of unusual nonlinear effects and chaotic behavior in very familiar settings. The new dynamical systems concepts shaved up in macroscopic systems such as fluids, common electronic circuits and low-energy Lasers that were previously thought to be fairly well understood using the classical paradigms. In this sense, the chaotic revolution is quite different than that of relativity, which shows its effects of high energies and velocities, and quantum theory, whose effects are submicroscopic. Many demonstrations of chaotic behavior in experiments are not far from the reader's experience.

Period Three Implies Chaos
Over the past decade chaos has become a very lively subject of scientific study, among with the periodic orbits for continuous maps and the idea of sensitive dependence on initial conditions. The existence of a period – three orbits along implies the existence of a large set of sensitive points, is infinite.

A chaotic orbit is a bounded, non-periodic orbit that displays sensitive dependence. When we give a precise definition of chaps, we will find that the discussion is simplified if we require a stronger definition of sensitivity, namely that chaotic orbits separate exponentially fast from their neighbors as the map is iterated. A much simpler fact about continuous maps is that the existence of a period three orbit implies that the map has periodic orbits of all periods. This fact doesn't say anything directly about sensitive dependence, although it guarantees that the map has rather complicated dynamical behavior.

It is one thing to find "chaos" in a mathematical model. A much more significant finding would show that the model is true enough to a real-world system that its chaotic behavior can be reproduced in the laboratory.

The concept of an unstable steady state is familiar in science. It is not possible in practice to balance a ball on the peak of a mountain, even though the configuration of the ball perfectly balanced on the peak is a steady state. The problem is that the trajectory of any initial position of the ball near, but not exactly at, the steady state, will evolve away from the steady state. The ball eventually moves away from the peak and settles in a valley, at a lower altitude. The valley represents a stable steady state. One type of behavior for an initial condition that begins near an unstable steady state is to move away and be attracted by a stable steady state, or perhaps a stable periodic state. It is common to see behavior like

this, in which unstable behavior is transient and gives way eventually to stable behavior in the long run. But there is no reason that an initial condition starting near a source is forced to end up attracted to a sink or periodic sink.

A chaotic orbit is one that forever continues to experience the unstable behavior that an orbit exhibits near a source, but that is not itself fixed or periodic. It never manages to find a sink to be attracted to. At any point of such an orbit, there are points arbitrarily near that will move away from the point during further iteration. Lyapunov numbers and Lyapunov exponents quantify this sustained irregularity.

Fractals
A fractal is a complicated figure, does not simplify when it is magnified. In the way Euclidean geometry has served as a descriptive language for the classical mechanics of motion, fractal geometry is being used for the patterns produced by chaos. Trajectories of the two-body problem, for example, consist of conic sections: ellipses, parabolas, and hyperbolas chaotic attractors, on the other hand, often have features repeated on many length or time scales. Scientists know a fractal when they see one, but there is no universally accepted definition. B. Mandelbrot, a mathematician at IBM, coined the term "fractal" in the 1960's. It is generally acknowledged that fractals have some or all of the following properties complicated structure at a wide range of length scales, repetition of structures at different length scales (self – similarity), and a "fractal dimension" that is not an integer. Perhaps the simplest geometric object that deserves to be called a fractal is a cantor set.

Chaotic Attractors
An important aspect of explaining dynamical phenomena is the description of attractors. Newton knew of two types of attracting motion that systems settle into: the apple sitting on the ground is in equilibrium, and the planets in the solar system are undergoing periodic, or more properly quasiperiodic motion, at least to good approximation. For the next 300 years, these were the only kinds of motion know for simple dynamical systems. Maxwell and Poincare were a small number grew, but it was not until the widespread availability of desktop computers in last quarter of the 20th century that the third type of motion, chaos, became generally recognized.

If chaotic motion is to be observed in the motion of a physical system, it must be because the set on which the chaotic motion is occurring attracts a significant portion of initial conditions. If an experimentalist observes a chaotic motion, he has chosen often randomly, an initial condition whose trajectory has converged to a chaotic attractor. This motion could perhaps be described as "stable in the large" (it attracts a large set of initial conditions) while " Locally unstable" (it is a chaotic orbit).

A chaotic orbit is not periodic or asymptotically periodic, and it has at least one positive Lyapunov exponent. On the other hand, a chaotic attractor is a forward limit set. It is in some sense what remains after throwing away the first one thousand, or one million, or any large initial number of points of a chaotic orbit. That means that the orbit continually returns to the vicinity of these points far into the future. The definition of forward limit set of an orbit is the set of points to which the orbit returns arbitrarily close, infinitely often. Points in an orbit may or may not be contained in its forward limit set. The forward limit set may have no points in common with the orbit, as is the case with the forward limit set of an orbit converging to a sink. In this case the forward limit set is one point, the sink that is approached by the orbit, as closely as you specify and as far forward in time as you want to require. The orbit is attracted to the sink.

What is an attractor?
The term attractor is used for the forward time limit of an orbit that attracts a significant time limit of an orbit that attracts a significant portion of initial conditions. A sink is an example, since it attracts at least a small neighborhood of initial values.

An attractor should be irreducible in the sense that it includes only what is necessary. The set consisting of the sink together with one of the orbits approaching the sink is also a set that attracts initial conditions, but for the reason that it contains the sink. Only the sink is actually needed. Irreducibility is guaranteed by requiring that the attractor contain a dense orbit, an orbit that comes arbitrarily close to each point in the attractor.

Besides irreducibility, the attractor must have the property that a point chosen at random should have a greater- than – zero probability of converging to the set. A saddle fixed point is irreducible in the above sense and does attract orbits for example, the one whose initial condition is the fixed point itself. However, this initial condition is very special; the definition requires that an attractor must attract a set of initial values of nonzero state space volume.

Chaos introduces a new twist. Chaotic orbits can be attracting if the forward limit set of such a chaotic orbit contains the orbit itself, and therefore contains a dense orbit, then the attractor is a chaotic attractor.

Concluding all the above, there are four very important characteristics of the chaotic systems that have effect to our application:

1. Apparently, insignificant inclinations, enlarge through the pass of the time. In other words, very small causes can produce very big results.

2. Chaotic systems are dynamic systems, and their behavior are chnaging through time.

3. Chaotic systems looks like fractals. They tend to reproduce the same pattern in all the measure scales.

4. Chaotic behavior is a result of the feedback between the parts of the system.

The very important characteristic of the chaotic systems, that interest us, is that their behavior is never reproduced in the same way wherever is the starting point of the system, we are not in a position to describe its certain path till the end. Very small changes relating to the starting point can cause parths with big differences.

The behavior of chaotic systems is changing through time, and it is an emerging procedure. That means that we are not in a position to know the evolution of the system from the beginning and there is a need to follow the procedure from the beginning to the end. Researchers and scientists want to know not only the final picture of the chaotic system, but also the "born" of the system, the certain path it will follow and the way it will conclude in a period of time.

For all the above reasons, libraries must be in a position to provide this new service. This can be done with the software we will establish.

The Digital Libraries concept and the appropriateness to chaotic models

Definition
The virtual library has been defined as the concept of remote access to the contents and services of libraries and other information resources, combining an on-site collection of current and heavily used materials in both print and electronic form, with an electronic network which provides access to, and delivery from, external worldwide library and commercial information and knowledge sources. In essence, the user is provided the effect of a library, which is a synergy crated by bringing together technologically the resources of many, many libraries and information services (11).

In 1995 statement, the US ARL identified 5 very general elements common to all definitions of the digital library current in the first half of the decade:

1. The DL is not a single entity.

2. The DL requires technology to link the resources of many libraries.

3. Linkages between DL and information services are transparent to users.

4. Universal access to DL is a goal.

5. DL collections are not restricted to document surrogates but include digital artifacts that have no printed equivalent (1).

The digital library we have started to construct and propose here fulfills all the characteristics of the above definition as well as the following basic potentials:

1. Reduces constraints for time and space,
2. Supports the creation and use of new more dynamic, integrated formats for representing data, information and knowledge,
3. Can support new forms of group collaboration in the creation and use of information; new communities of practice,
4. Enables customization and personalization of information, including assistance with management of information overload (11).

Digital library is human activity systems that unite readers, authors, librarians and researchers with electronic materials, resource streams, computer equipment and know-how (1). Rather than looking at the digital library as a specific technology, we are interested in placing it in the context of a specific learning and teaching environment.

The whole range of initiatives currently indicated by the term digital libraries. The digital library is an often-global organization of scientists or scholars who use advanced technology to create and share information over the network. This information can be related to research outcomes, but might also consist of source materials, survey data or data from ongoing research (9).

Characteristics
The documents or resources in the digital collection will be of very varied nature, as indeed are physical documents. A digital library collection, which may be logically defined as a set of criteria for selecting resources from a broader information space, may be less formally understood as a set of digital objects, with the following characteristics:

1. Unique: they should be identifiable as the same resource in whatever format or medium they are instated,
2. Coherent: they must present a logically coherent quantity of information.
3. Significant: they must include viable and useful information content.
4. Control: the objects are prepared and organized according to some standards, and are preserved in some way.
5. Access: they must be accessible by the libraries' systems (1).

The database of chaotic models includes digital unique objects, characterized by the coherence and significance and providing access via network.

Authors store their work in a database, which can be accessed over the network by everyone in the same field. Efforts are now being made to group similar initiatives (also known under the name open archives) in a consortium to achieve a universal service in the area of scientific communication (9).

A library's holdings will be defined by access, not by possession. Much of the library's material are delivered in electronic form, or printed on demand. There are however, some inherently electronic objects that cannot be examined except through computer and networks. Furthermore in our case, scientists are interested not only for the final definite form but also in the dynamical formation, in the

way fractals and chaotic models are formed. So, the electronic preservation is the only format or medium, which can depict the continuing formation of models and the digital library the only mode of their retrievable organization.

Collection
Although a major aspect of the digital library is its ability to provide access to material across networks, there will still be an identifiable "collection" available to patrons of that library. In other words, digital libraries contain discrete, identifiable and relatively permanent, information artifacts. These documents will be varied in nature, but will certainly include items analogous to printed books and journals. Different commentators view the extent to which a digital library encompasses other forms of material very differently. Other items will take the form of datasets of various kinds - geographical, environmental, scientific, statistical, etc (1).

So, there is an immense variety in the way expression in information sources has been shaped. Not simply in terms of intellectual structure, but also in the kind of expressive medium used; that is, whether the expression is textual and discursive, textual and elliptical, numeric, graphic, composed in a special language such as mathematical or chemical notation and the like. Indeed, some information sources may be distinctive by appearing to be combinations of many of these motifs or by appearing to be chaotic in their conception and execution, at least in terms of some standard of expression (8).

There will be a continued emphasis on text in digital libraries. Although digital libraries will provide access mainly to textual information, they will still have a predominance of multimedia products of various forms. This seems to generally agree, except for specific application areas, e.g. geographical information systems, or genome databases, where text will be a minor part (1).

The digital library model is no longer based on the traditional information chain, but on a network of researchers who create and distribute knowledge in the form of information objects. They include text corpora, data collections, audio-visual materials, simulations, embedded software applications, etc.

These technologies are the concept of multilateral documents, which adds useful functionality to document content, that is a new concept of scientific communication. And that's exactly what we seek for this collection, which among others gives the opportunity to researchers to observe the evolutionary formation of every model, an important achievement to this scientific discipline.

Material technical organization
A digital library will include an equivalent of the traditional catalogue. Though it will require a richer set of metadata descriptors and standards for dealing with the variety of information artifacts to identify (1).

It is not up to librarians to produce knowledge in most cases. The distinctive role of libraries is to organize the information have been produced and to facilitate access to it. In other words, concerning digital environment, librarians could plan and design electronic publications, design and operate electronic networks, organize electronic information files, devise and implement new types of information services and keep clients aware of newly available information sources (12). We therefore need to focus on knowledge and learning rather than purely on information, we must make sure that libraries support learners in finding the information they seek (5).

Bibliographic control is truly an area that needs serious rethinking. In a digital library environment where digital artifacts co-exist, librarians must go beyond generalized tools such as subject headings and classification to streamline access to the world of networked information. New organizational tools must be devised in order to describe the intellectual contents of digital library materials and establish links between them (11). Then digital artifacts could be enjoined with other tools to establish intellectual connections between artifacts and organize networked information into logical structures.

Perhaps, the greatest uncertainty, from the perspective of cataloging, is just what the new digital materials will be. Our current order carves up the bibliographic universe into (relatively) discrete, stable and long-lived units. But now, there is the potential at least for a great deal more variability and mutability of materials, and for a less rigid boundary between items. New genres, new categories of

description, new institutions and practices have not yet arisen to stabilize this material. All of this together would constitute a new order, or substantial changes to the old order, as yet unrealized (6).

The digital library of chaotic models is going to include not only the models of the researchers who participate but also some other chaotic models, basic and fundamental ones, invented in the past, after permission of the researchers or authors. The information that the present database includes and can be retrieved, is the following:

1. An alpharithmentic code, which represents the model and replaces the title.
2. The authorship.
3. The characterization of the model: deterministic, chaotic or biological, chemical etc. This categorization constitutes the subject analysis of the database. It is proposed a hierarchy to be established, such as simple /complex or general/ special. The reason is that the most of these models are related to each other and some models originate from others. Moreover, this is the evolutionary procedure of scientific investigation.
4. If the model is already published, the title, the publisher, the imprint of publication.
5. The time and place of the model' s invention.
6. The Organization, whom the author works for.
7. Size in bytes.
8. The time needed for the model to be completed on the screen.
9. Appropriate technology, interfaces etc.
10. Description of the model's form.
11. An abstract of the scientific documentation, the interpretation and the equations.
12. Keywords.

The software provides the browser and search selection. Search can be performed by authorship, title, keyword, free text, subject descriptors. The browser provides the classification schedule of the models. Under each descriptor, there is a list of the titles of the models associated with this term. By choosing a title, one can receive information about the model, while the choice "show" permits the gradual formation of the model. Although subject links between models need to be examined in more detail, that is impossible up to the moment. Copyright protection is taken into consideration and only authorized users can access to some fields of the unpublished models.

Users and the circulation of knowledge

The work practices described by scientists are heavily influenced by a concern for getting credit for findings and verifying that their findings were original. In their interviews, they described high stakes in terms of obtaining competitive funding, raises and promotion based on priority of discovery. Therefore they expressed a sense of urgency in terms of creating, finding, and utilizing materials in a timely manner. Like molecular biologists, computer scientist's work required them to keep up with very current materials. However, priority of discovery was less of an issue for them because there were several possible solutions and implementations for the same problem. Note how inter-organizational aspects for their research projects influenced their work practices (2).

Attempting to meet similar user needs, the organization of the chaotic models in a single digital library offers researchers a basin where they could find work that interests them and a start point for communication.

The concept of interoperability reflects, in outline, the need that information in disparate formats and media to be accessible by users through, as far as it is sensible and appropriate, a common interface, with a single authentication stage.

Digital Library users are considered as information -seekers with clear goals and competent skill to interact with archival databases. They insist in decreasing barriers to access and increasing speed of research publication even to expensive scientific data. Using DLs help researchers transcend time and place limitation (3).

Ethnographic studies of actual workplaces reveal the diverse mix of materials, digital and otherwise, commonly in use and offer no suggestion that this diversity is diminishing. By hewing to an agenda enlivened by this faith, I believe we are missing some important research opportunities, such as integrating heterogeneous (digital and non-digital) collections and providing tools to organize and search them (7).

Libraries, digital or otherwise, carry a strong symbolic charge. On the face of it, they are just one element in the larger circuit through which information travels from production to ultimate consumption. In this respect, they are on a par with the other elements in the circuit: authors, publishers, distributors, and communities of users. But libraries have come to symbolize, and to exemplify the values we impute to, the entire circuit. What we say about digital libraries and how we understand them embodies and signals out attitude toward the place of information in our culture. To this extent, it is potentially of great consequence not only how we construct digital libraries but also how we talk about them, and whom we include in the conversation (7).

Organizational changes

The argument to be put forward is that the real issue is not the transformation of print-based libraries towards new models of digital service provision, but a change in responsibilities for scientific communication, resulting in an important transformation of institutional roles in the information domain, including the role of the library. The information chain model identifies specific roles, such as knowledge creation, publishing, archiving, intermediation and use and actors that perform these roles, such as researchers or research institutes, publishers, libraries and users (9).

What is interesting is that it not only defines roles, actors and functions, but also implicitly defines responsibilities. In practice, academic institutions regard only knowledge creation as their responsibility. Publishers take on the responsibility for creating information products that serve as a vehicle for knowledge distribution, and libraries are responsible for archiving and availability of information products. There is no overall responsibility for scientific communication, held by a single actor. One might expect academic institutions to bear that responsibility, but until now that has not been the case (9).

Libraries by the occasion of the digital libraries development and because of them could develop the large body of initiatives aimed at self-publishing by academics and academic institutions.

Most, if not all, libraries will remain indefinitely in a "hybrid" state, with digital and non- digital resources offered side- by - side. These conflicting assumptions are freely offered as alternatives in the literature. The first is favored, in general by those working with scientific, technical and commercial materials, especially those from a computing background, and those involved in "leading edge" research; the second by those involved with research –based collections, especially in the humanities, those from a librarianship background, and those involved in service development. Espousing one or other of these assumptions is equivalent to a belief in the digital library and the hybrid library model respectively (1).

Implementation of the digital library concept implies organization and cultural change. While this seems to be agreed by all writers who mention it, which is an increasing number, there is some difference in emphasis as to whether this change affects primarily library/ information professionals, users, or the whole environment including all the players. Those commentators who devote most careful thought to this issue seem to generally favor the latter option (1).

Conclusion

Eventually, printed information will become more or less invisible because most users will regard the network as there one and only source of information. This is a practice, which already is becoming visible in the information behavior of many students, and even researchers (9). Direct communication between authors and uses is actually not a recent invention: it has always been possible to "bypass" the publisher. The methods - electronic mail, desktop publishing, remote bulletin boards, and so on- are new, but the relation is not (4).

Although these various forms of self-publishing by the academic community do not constitute a fundamental change in the information chain, they could develop procedures that might be crucial for the future of scientific communication, the information chain and the actors involved. That development is the increasing tendency of the academic world to take on responsibility for the entire process of scientific communication, rather than leaving the responsibility for specific and important functions to other actors (9). For these reasons, we invite every interested organization to join us for the further development, evolution and expansion of this digital library, in any way.

Bibliography

1. Bawden, D. and Rowlands, I. Understanding digital libraries: towards a conceptual framework. British Library Research and Innovation report, 170. BL research and innovation center, 1999.

2. Covi, L. Material mastery: situating digital library use in university research practices. Information processing and management, 35(3) 1999: pp. 293-316.

3. Covi, L. Social worlds of knowledge- work: how researchers appropriate digital libraries for scholarly communication, 1996, 15p. at http://www.scils.rutgers.edu/~covi/doc/social-worlds-asis.html

4. Duff, A. S. Some post- war models of the information chain. Journal of Librarianship and Information Science, 29(4) 1997: pp. 179-186.

5. Fitzgerald, M. Information, knowledge and learning: the library in the digital age. 1997, 6p. at http://www.cni.org/regconfs/1997/ukoln-content/repor~20.html

6. Levy, D. M. Cataloging in the digital order: Proceedings of the Digital libraries 95. 15p. Email: dlevy@parc.xerox.com

7. Levy, D. M. Digital Libraries and the problem of purpose. D-Lib Magazine, 6(1) 2000, 8 p., at http://www.dlib.org/dlib/january00/01levy.html

8. Miksa, F. L. and Doty, P. Intellectual realities and the digital library: Proceedings of the Digital Libraries 94. 7p. at http://www.csdl.tamu.edu/DL94/paper/miksa.html

9. Owen, J. Mackenzie. Digital libraries and scientific communication: transforming the information chain: Proceedings of the Symposium: Weaving New Webs: Cooperation for survival in the new millennium. Aristotle University of Greece, British Council, Thessalonica, 20-21 March 2000. 8p.

10. Watts, R. Re-engineering the learning process. 1997, 9p. at http://www.cni.org/regconfs/1997/ukoln-content/repor~23.html

11. Drabenstott, K. M. Analytical Review of the Library of the Future. Washington, Council on Library Resources, 1994: 200p.

12. LANCASTER, F. W. Future librarianship: preparing for an Unconventional Career. Wilson Library Bulletin, 57(9), 1983: pp. 747-53.

Back to Contents

Last edited by J.F., 23rd September, 2000.